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ABSTRACT

An ecological approach to a psychological study of language is presented in this paper. Such an approach is based on the understanding that the process of perceiving an object or event is based neither in images or pictures nor in verbal or symbolic structures. In order for objects and events to become knowable, higher order cognitive processes must occur because these processes capture crucial qualities of structure and form. In light of the presupposed relationship between function and form, a computer simulation of neurotic behavior is critiqued. An 18-item list of references is included. (DB)

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Simulation of Action-Event Cooperation

Emergence of Knowing

Bernhard Bierschenk

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Abstract

A graphical expression or display has to depict crucial structural qualities of thought in such a way that a person can capture its intention by extracting higher order components. These are assumed to be shapeless and formless. The present article gives a demonstration of what is meant by experimental manipulation of the Function factor as well as of the outcome when both the Type and the Function factor are allowed to covary.

When a psychological analysis is more oriented toward intrapersonal instead of interpersonal aspects, it may be important to study the components that define tension in a person--environment system. But only the dynamic cooperation of the Type and Function factors leads to the abstraction of higher order functions which seem to underlie any categorisation effort and hence the emergence of knowing.

With the help of a series of "direct perception" experiments it is shown that direct perception captures the ecological significant aspect of a concept, demonstrated with the concept of growth.

The Agent-action-Objective (AaO) paradigm constitutes the basis for a synthesizing of successive segments in the development of a cognitive helical structure (Bierschenk & Bierschenk, 1989). Every novel phase starts with a twist where the dependent and interacting variables of the preceding phase become the independent and thus manipulable factors of the successive phase.

The Type-factor. The normative perspective imposed on the categories that form the basis for understanding as discussed in Bierschenk and Bierschenk (1989) followed the Aristotelian way of classifying by means of a list of critical features with clear cut boundaries. This logical model is not cognition oriented, which has been demonstrated by Rosch (1975). She wanted to find out what makes it possible for something to be understood as a member of a category. The assumption is that, if a structure exists and can be named, or if a name exists that has structure, then this implies a category. Underlying this assumption is an awareness of the existence of "artificial categories" (i.e. classes) employed in science with different characteristics than natural ones. For the experiments Rosch used colour categories and the task to be performed was to judge whether or not a figurally presented item belongs to the same category as the category name indicated by priming. Her experimental results showed that, although the category names used are quite concrete, there is no indication that visual elements are cognitively represented, i.e. lines, angles and the like pertaining to shape. Instead, what seems to facilitate the perception of instances of category membership are shapeless and nameless invariants, by Rosch called the "meaning" of the name. Her study showed that invariant structure is abstracted from groups in which membership is judged with respect to increasing or decreasing similarity to a prototype (and not a stereotype). Thus, categories show an internal structure that contradicts the Aristotelian assumption.

The Function-factor. Experiences of shifts between logical types (i.e. classifications) are provided in an information rich environment, which lead to the understanding of meanings behind functions. In "natural intelligence" understanding is functional and is therefore

integrated in the growing awareness of types of objects. These developmental phases have been demonstrated by Andersen (1975). Her study aimed at figuring out how a child comes to an understanding of an object (drinking vessel) as a cup or a glass. An array of drinking vessels were to be assessed by children of different ages. The tasks were naming, sorting, giving definitions, and choosing the best exemplar of each category. Generally seen, cups and glasses are of the same logical type, although of varying depth, width, shape and general contour. Andersen's experiments show that differentiation based on features ("physical properties") is governing the initial understanding of the objects. But with increasing environmental experience (age) features become meaningless for categorisation. With increasing age the "functional properties" determine the way of categorizing the objects. As a result, the labelling of them, for example, shows a greater variation, such as in "measuring cup", "beer mug", and "egg-holder", thus, directly effecting the language expression. Seen in a developmental perspective children look at objects in relation to the events in which they have been involved. From a perceptual point of view, the dynamic interaction between type and function leads to the abstraction of higher order functions, which seem to underlie categorisation efforts. The importance of context is obvious in this kind of learning, such as cultural experience. This implies that there is a value integrated with the function without which the transformation from one type of experience to another would have no cognitive sense.

Mobilization of the Function Factor by Manipulating Evidence and Believes as Behavioural Condition

It was Freud who introduced new methodological approaches in psychology, among other things by proving the significance of psychological pain or bereavement in behaviour reinforcement. His psychoanalytic theory has not only been the starting-point for the laboratory experiments with animals in modern psychology, in which reward and punishment have been used as steering mechanisms and

basis for quantitative measurement of behavioural change. It has also given rise to a model for computer simulation of neurotic behaviour (Colby, 1973) in which social modelling is an important control factor for both perception and evaluation, and the experience of intensity.

Colby's (1973) purpose is to represent those conceptual dependencies that are governing the perception of neurotic conflict. The key concept is anxiety against which input information is "idealized" and, thus, looses its ecological significance. A neurotic state can only be fully diagnosed through language, a reason why the therapist-patient interaction chosen is characterized by the discourse function of linguistic elements. Of importance for neurotic conceptualization is the imperative mood and the modality variations as expressed by modal auxiliaries such as "must" and "ought". A sentence is represented as an SVO model and the lexical entries to be processed are those syntactic elements and their modifiers.

The neurotic person's lexicon consists of a set of believes about a defined domain, which may be family relations ("I hate my father", "I will never marry") or some other domain that may cause anxiety, such as the underworld represented in terms of gambling, Mafia ("The Mafia is after me", "We live in a world of gangsters"). The psychological setting requires the linguistic units to be adequately marked. Thus SVO is semantically specified as Agent-action-Objective. But it is important to note that, in contrast to an Actor category denoting a role player characterized as a type, Agent denotes a dynamic function marking the centre for an intentional act. As will be obvious from the following discussion, Colby is missing the essential link by his keyword approach. Especially within this theory of neurotic behaviour, intentionality and synthesis of behavioural consquences in the sense of distinguishing the self from others is of great significance. Persons or phenomena talked about should, namely, cause anxious reactions only when perceived as agents towards the self. This implies that the system needs to contain a mechanism for identifying intentions and synthesising consequences. These have to be interpreted against a cognitive structure in which the categories have predefined relations to each other and not as in Colby's case against a system of classes with weighted lexical entries denoting benevolent, neutral or malevolent intention. In order to incorporate

human value into his simulation experiments he would have been urged to utilize the Schema-approach. For example, an input sentence "You get electric shock" is processed by rules for detection of malevolence (The path is indicated by cursive strings):

Malevolence←mental harm ← induced attack
↖ *physical threat*←*direct attack* ← *You get electric shock*

The state of malevolence constitutes the conceptual prerequisite for the next input whose interpretation is thus dependent on the specified level of anxiety reached.

In a conceptualization of the kind used, there seems to be a closed word-concept relationship, but this is due to the concept being linguistically represented by primarily personal nouns and pronouns. The non-linguistic approach is obvious from the fact that discourse elements, as in "Do you believe I hate you", make problems for semantically oriented AaO coding.

A first presentation of Colby's system appeared in 1966. However, this section relies on the description which appeared in 1973, since this edition is organized in such a way as to fit the scope of cognitive science. The computer simulated behaviour model presented in Figure 1 performs the characteristics of a "paranoid behaviour". The term is composed of the Greek "para" = beside, and "nous" = mind and was originally used to designate the state of being out of one's mind. Colby builds the simulation on the neurotic person's typical characteristics of showing ritualized behaviour.

The development of the model is based on the conviction that "believes" are the result of basic psychological processes. At the beginning of the model development, neurotic believes were processed, whose features are an intense and sharp focussing and a concentration on details. The most characteristic features of neurotic (bound) behaviour are mistrust and insecurity, and also a dogmatic manner. Dogma is used to overcome mistrust and ambivalence, and to compensate for them (Shapiro, 1965).

At a later stage in the model development, as a contrast to

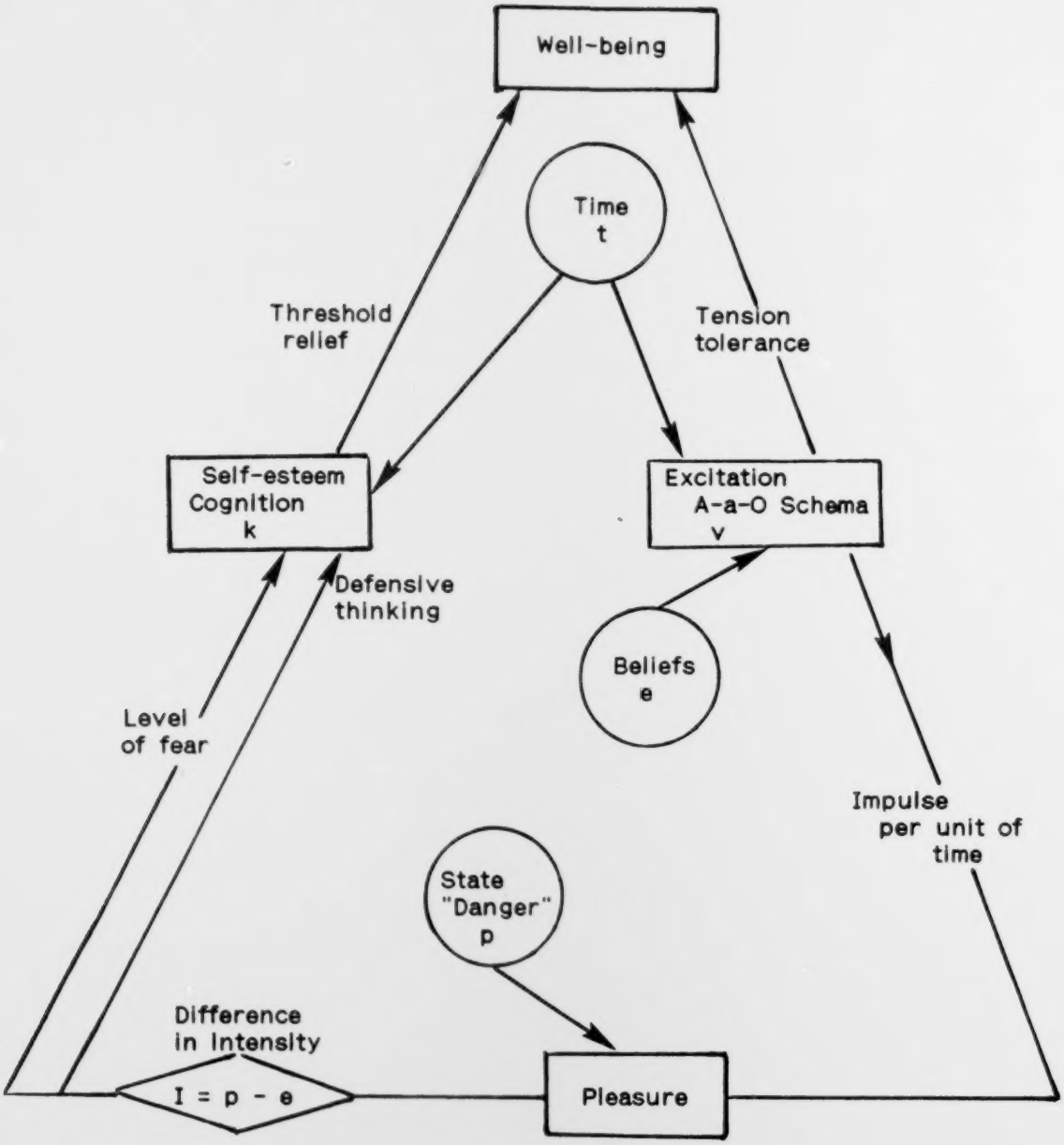

Figure 1. Representation of Colby's psycho-physical model for a computer simulation of neurotic behaviour

At a later stage in the model development, as a contrast to neuroticily based believes, a set of "normal" believes were created which concerned mother-child relations. Such relations were chosen as being an area where it could be expected that the believes would change very little or

not at all during the course of experiment. Due to a rapidly growing number of believes the interest was finally shifted toward the simulation of paranoid believes. This decision is reported to be a result of the fact that theoretical grounds already existed for an explanation of the process and that there was also a conception of how such a model would function.

The paranoid person alone, according to Shapiro (1965), shows a psychotic loss of perception of reality and a severe disorder in his normal functioning. The paranoid person does not conceive processes of communication and other situations to be something which should be perceived as they are but as what they signify. The paranoid person shows a loss of proportion perception. The surrounding world is autistically interpreted, although mostly precise in factual details. The paranoid person meets reality half way. He or she lives in constant preparedness for emergency and a constant state of total mobilization, caused by a constant pressure from rigidly modulated impulses and affects.

Psychological State Change

Colby (1973, p. 254) discusses the importance of analogy making in science and of examples taken from physics, but at the same time affirms "In human research one should never use examples from physics". Despite this assurance, his model seems to be anchored in psychophysical thinking. The three basic components taken over from physical science and generalized are:

(1) persistence, represented by the state component Danger,
(2) extension of a neurosis modelled with the neurotic person's spontaneous introspection, i.e. free associations represented by a random generator, whereas
(3) the time factor is used for simulating a sequence of states.

From these three basic components all the other components in the model are derived. Exitation, for example, may be seen as a measure of the intensity in the information flow. Believes expressing exitation are considered relevant in Colby's representation. A conflict or tension are

simulated through an intuitive judgment of the intensity of every single belief. The values vary between -3 and +3. The four basic parameters of significance for an operationalization of a simple conflict theory of neurotic behaviour consequently are:

(1) experience of intensity,
(2) range of variation in the tolerance,
(3) threshold value, and
(4) observable differences.

Pleasure may be seen as the model'smomentum. However, in the model, pleasure is not expressed as a product the way momentum is in physical models, but as a difference. Through a comparison of the valued intensity of a belief represented by the Pleasure component with the intensity of a belief represented by the Exitation component it is decided whether the resulting tension exceeds the maximum threshold value four (4). If that is the case, the result would be a defensive thinking. If not, the resulting difference would imply an increase of the anxiety level. By a fluctuating tension tolerance the faith of a dominating belief is decided within a simulation cycle. Does the resulting tension fall below the threshold value, the dominating belief is expressed in the form of a computer output. Otherwise it is subject to different transformations.

Self-esteem denotes the extent to which the neurotic person believes in his ability to do something or to change his thinking or behaviour. In this sense the Self-esteem component expresses the individual's force (cognitive power). Colby (1973 p. 254) argues that there are useful analogies which can be taken from "classical mechanics" but it would be wrong to try to explain non-observable theoretical concepts like it is done in physics by postulating a "non-observable gravitational force". Instead of a differentiation over time different rules of transformation for conflict solving are used in the simulation model, such as:

Deflection	➔	shift object (not self)	➔	SV
Substitution	➔	cascade verb	➔	S( )O
Projection	➔	switch subject (self)	➔	( )V( )

and object (not self)

Defensive thinking, for example, utilizes the strategies for the following transformations:

Belief: "I hate my father" transforms to "I hate my brother"
or "My father hates me".

Defensive thinking or reduction of anxiety depends partly on the rapidity in the increase of intensity pro time unit, partly on the strategies developed for modulating the relief threshold. According to the model, self-esteem is a function of different "ought" and "must" imperatives, which are in conflict with an actually dominating belief. A conflict, then, is defined as tension between believes leading to contradictory consequences. This contradiction is defined according to a set of inference rules like

If X disturbs Y then Y avoids X
If X wants Y then X seeks Y
Behaviour concepts: Attainment, Avoidance

The proposition that a neurotic person X believes Y has the same meaning as some conditions that steer the system. For that reason, it will be important to be able to express the power of a certain belief.

Well-being denotes the neurotic person's psychic power. It is simulated through a combination of tension tolerance and relief threshold. In this way the simulation process takes into account:

(1) the need for relief or reduction of instinctive impulses and
(2) the system's success in developing defence.

The Well-being component denotes the modelling of psychic power as a function of a time dependent self-esteem and of believes valid over a certain period of time.

The Reduction-Deduction Cycle as Communicative Link

Since the behavioural characteristics of the neurotic person have been identified primarily through an abstraction of the content in the

communication between client and counsellor in clinical settings, Colby choses to represent relevant believes by a simplified language. As point of departure, all believes are represented by the AaO paradigm. With AaO paradigm as a basis it is possible to identify the "concept" as unit of analysis, which can be given a name and used for an unambiguous definition of cognition. Every belief is based on a conceptual structure whose credibility may be denoted as well as its motivational effect (degree of interest).

The general procedure in the evaluation of the information within a model requires a judgment of the informational value with respect to a defined group of persons. This is done through a comparison of stated believes expressed by the group and put into the data base associated with the model. Believes are here defined as presentations of situations or facts together with rules for their organization. Their credibility may thereafter be evaluated with reference in a 2x2 matrix, in which the x-axis represents the believes stored in the system and the y-axis the statements made by informants. Colby defines credibility as a function of (1) preliminary credibility of source, (2) direct evidence, (3) ground, and (4) consistency. Each informant initially gets a low positive value of credibility. Direct evidence is decided upon through identity matching against the data base. Ground of a statement, finally, is decided on the basis of weighted average score for the credibility values associated with the stored believes whether negated or not.

Consistency is defined by Colby as conditionalized probability A/A+B, whereas ground is defined as conditionalized probability A/A+C. With this basis it becomes possible to decide quantitatively the validity of a belief. If a found evidence supports a belief and its degree of credibility corresponds to its power of evidence, then the belief is "sound", in Colby's terms. Similarly a belief judged to be invalid is not supported by the data base, or its assigned degree of credibility is higher than what the evidence allows. Rationalization is defined as a process in which a belief is given with the purpose of justifying an already chosen preference.

A data base with descriptions of situations and rules describing the reactions allowed between different situations plus a word list of attributes with appropriate links to Agent and Object(ive) codes makes

possible rationalizations as illustrated by the following examples: "I hate atheists". By a deletion algorithm the system can transform this hate to "I hate doctor X". According to the attribute list, doctor X, namely, is described as an atheist. Since the belief matrix already contains the attribute, the model can with relative success transform a new appearing hate and thus approximate neurotic behaviour.

After this detailed outline of the experimental variables, let us turn to more concrete exemplification of how Colby's model is used, what is meant by its simplifying of language expressions, and how it actually works in practice. Communication with the model occurs by typed messages. The task of the algorithm is to understand and interpret input expressions in English and to produce affective belief, and language responses that characterize the paranoid mood of the human mind. Almost all diagnoses of psychotic illness are made on the basis of language behaviour, which implies that language must carry specific information about cognitive structures typical for such an illness. Further, the diagnosis is made by the help of a dialogue or interview, which usually has a topic. Finally, the method involves an interaction of a certain kind, whose typical characteristics must not be confused with the ones of the topic. In short, the analysis has to take into account language expressions on several levels simultaneously, at least in Colby's case an observation and a communication level. A possible third level, the action level, is "believed" and cannot be directly accessed.

The action level is represented as a list organization of facts and conceptualizations. Each fact is a three-place predicate leaving out tense, location or any adverbial modifier. A fact list can describe situations like:

(CHILD1 HAS AGGRESSIVENESS)
(SELF NOTLIKE (CHILD1 HAS AGGRESSIVENESS))

The first description is embedded in the second. NOTLIKE is the verb element functioning as "dislike". The child has a number in a list of family relations. Articles, determiners and prepositions are incorporated into their respective nouns or verbs. Conceptualizations get the same representation in which the first element stands for Agent, the second

for Action and the third for Object(ive) (or another conceptualization):

(SELF PRODUCE (HOUSE TO BE CLEAN))
(SELF PREVENT (CHILD1 PLAYWITH MATCHES))

Situations can change or remain the same. By actions agents can produce or prevent situations. For example, they can leave a situation unchanged or let a situation happen. Further, for an unambiguous representation "constrained" variables of the following type were invented:

(THEPARENT SLAP HISCHILD)

The list of family relations states which concepts should be substituted. Colby reports about the frustrating naming process when matching natural English against this kind of representations. Thus the input format was developed with limitations to certain positions in a subject, a verb and a modifier field. In the same way as a therapeutic situation involves observations, one could talk about an observation level on which questions and assertions occur as input as well as output in this reduced language. Now, the interpretation of questions like: "What is your occupation?" "Where do you work?" or "Do your have a job?" may all result in an output answer like: "I work at Sears." and/or a description of what this work means (actions, predications, situations). According to Colby (1973, p. 270) the computer program developed on the basis of the AaO paradigm, maps the elements of the input into an underlying conceptualization consisting of a configuration of concepts as exemplified above. The reason for this is that the mapping algorithm relies on keywords associated with a hierarchic organization of the topics. Basically, the logics of Boolean algebra works here as in any other "thesaurus".

The psychiatric interview is a communicative situation which has its typical phrases. In the so called "I-you-me" expressions, like "You anger me" or "Are you angry at me?" the direction must be correctly decoded. As direct observations these expressions are not as problematic as the ones starting with a so called meta-verb. From "I believe you are

afraid" a correct conceptualization must be inferred instead of "I believe you". The meta-phrases operate on a communicative level interfering with the observation. Only, it is doubtful why not communicative phrases like these could not be left out of the processing by formatting the input. After all, the diagnoses are primarily based on observations.

Turning to the communicative capacity of the model, it could be inferred that the cognitive structure of paranoia might be detected through an association of keywords to concepts and their relations listed in a "memory for actions and situations". This means that the programming is in some sense reduced to a data base editing problem by supporting domain specific concepts, such as the linkage "horses --> horse-racing ---> gambling ---> bookies ---> underworld ---> Mafia. Domain specific keyword search is notoriously insensitive to context. As can be seen from Colby's (1973) output:

Dr. Tell me something about yourself.
Pt. I went to the track at Bay Meadows a while ago.

A search with keywords like "something" or "yourself" lead to an uninformative comment, a case which would probably not happen when language is used in a context dependent manner. Further, it is difficult to judge the validity of the patient's comments without getting the full cycle of the doctor-patient interaction. Regard this sequence:

Dr. What happened there?
Pt. There's a lot of crooked gambling going on there.
Dr. Why do you think the gambling is crooked?
Pt. I have worried that gangsters have too much power in this country. (pp. 280-281)

The comment of an independent judge was that this patient is paranoid because of his first answer. Since "there" could be a reference to numerous gambling places, the only statement of interest would be the predication "crooked", especially when one evaluates the doctor's next question. The patient's following response gives some indication of the adaptedness of the keyword organization. Much more is difficult to di-

gest from this reading. After all, there is nothing in the research process that requires the researcher to chose between one or the other belief system. But it is pointless to study the individual's conceptualization without a conceptualization of the individual's surrounding environment.

Paranoia

It seems obvious that the understanding underlying Colby's belief system is that believes are nonobservable "theoretical entities", which, of course, are abstracted from observations. Otherwise they would be meaningless for theoretical purpose. This assumption causes fundamental difficulties for a simulation. It has long been observed in science that it is no easy task to create representative problems and to represent the relations, either abstract or concrete. Therefore, it is of utmost import to distinguish between theoretical and conceptual entities. Any scientist who works with simulators or experiments seems to be aware of this fact. Evidently, scientific activity usually concerns abstracted properties of statistical or paradigmatic kind, which are assumed to be representative of the scientific problem in question. Further, theoretical entities function in the service of hypothesis testing or inquiry into consequences, which is not necessarily the case for conceptual entities. The confusion of both entities leads Colby into the troublesome situation of not being able to differentiate out conceptualizations based on observable relations in human behaviour, that is, an observation sentence.

From an ecological point of view, it is also evident, that one cannot assign informational value to language expressions without a point of observation. In Colby's case the problem is solved by assigning each belief a tension score which allows for a simulation that concerns state change. Therefore, the only informational values of interest are changes in intensity from one state to the other. But Colby has not been successful in defining a representative set of situations, which means:
(1) that the point of reference is missing and
(2) that the intensity values are intuitively imposed.
Finally, he had to decide upon a topic which he chosed to anchor in personal believes and the perspective of paranoia. Consequently, he

equipped his simulator with the topic of gambling. Personal believes are thereby forced into an artificial world without any anchorage in real world events, which means that a belief cannot be differentiated from an observation sentence.

Mobilization of both Type and Function Factors by Behavioural Planning on Experiential Grounds

A concept is made up of dynamic and abstract relations whose boundaries are cognitively determined. This means that the individual's experiences can be successively integrated within this structure, enabling the concept to grow with the individual's experiential development. Concepts are emergents. They may be conceived as complex events. The perception of them, therefore, requires coping with change as opposed to the perception of objects. This kind of change is structural, however, and thus non-trivial. The perception of concepts encompasses an identification of the structure that remains over change, which means that the boundaries cannot be infinitely stretched. The growing of a concept is a preservation of structural invariance over time. This should have as its consequence that it is possible to directly perceive a concept once the structure has been determined and cognized, and that therefore the growth itself, the remodelling transformation process, would be perceivable as well.

In research on contour coding the line function has been used to study how an organism comes to meaning and understanding. But the line has also been the starting-point to illustrate that structural transformation of the edges of a surface is necessary, if it shall lead to information that can be intentionally used. The contour coding experiments of Pittenger & Shaw (1975 a; 1975 b) are used to illustrate the inherent character of concepts. It is shown that Gibson's assumption of "superordinate components" can be used to establish aging in faces. The experiments point out that a concept needs not be conceived in totality to be active part of a cognitive process.

In the following the nature of the notion "concept" will be illustrated with the aid of the concept "growth", because growth implies a systematic movement in which both the Type and Function factor, i.e.

non-change and change respectively, are unified making the concept immediately detectable.

Distinction and Abstraction of Regularities in Change

Pittenger and Shaw (1975 a; 1975 b) have studied transformation and growth in two experimental set-ups where perception of "aging head profiles" and "faces" were measured. This approach studies the perception of events in which object configurations or the shape of the objects undergo dynamic change. Growth is here considered to be an event which can be described by two components. One is the structural invariant specifying the identity of the growing face while the other is the transformational invariant specifying the change to be detected. Since growth must be regarded as a fundamental event, structural invariance is non-static. Thus changes in both components should contribute to the growth process and be the subject of perception of aging.

With the goal of examining the perceptual effect of the elastic component of the remodelling transformation the first reported studies (1975 a) were carried out as a series of Monte Carlo experiments by which a mathematical formula was used for transformation and assessment of the shape of facial profiles by shear and strain. The mathematical formula by which facial expression are transformed without destroying their identity was already known to the German painter Duerer around 1500 (Thompson, 1942, 1053). The first experiment tested the effects of the shape changes induced by shear and strain, in which the task required magnitude estimates of age. The results clearly indicated that a transformation of strain rather than of shear provides the best formulation of the transformational invariant. Increasing strain level made the profiles seem older. The second experiment tested "subjects'" sensitivity to small strains, which could show perception of very small changes in the relative shape of the profiles. Moreover, small changes of age seem to be most easily seen in young rather than old faces. A further experiment revealed that the transformation of strain did not destroy the identity of the person, since it was possible to distinguish two profiles differing in level of strain from an unrelated profile. On the basis of these experiments the authors argue that aging

would be a perceivable event and that form perception is a special case of event perception. Thus an object's static shape is not the primary information for perceptual identification. Its identity depends on the nature of the events in which it is involved and what remains invariant over change.

The experimental results have led the authors to test their hypotheses with real subjects and authentic faces (Pittenger & Shaw, 1975 b). In the study perception of age was assessed by using sets of faces from a year-book of school children 11 to 18 years old. The judging subjects were university students (18 to 22 years of age). The tasks were of the rank ordering type and were performed under both masked and unmasked conditions. Two dimensions of differences were accounted for, a longitudinal and a cross-sectional. Under the hypothesis that the former would preserve the basic structure over changes in age it could be shown that it provides more information for age than the latter, where differences are produced by both change in age and difference in structure.

The results showed that difficulty in ordering was not uniform along the age continuum but tended to be easier among the intermediate ages, i.e. the age in which puberty occurs and where growth therefore is most rapid. The result thus confirms the Monte Carlo simulation. Since growth rate is not constant in the period covered, but first accelerates then decelerates, the estimates were proven to be an S-shaped function of actual age.

According to the authors (1975 b, p. 142), observers have some knowledge of the effects of growth, perhaps in the form of a "typical shape" for a given age. But the cross-sectional variations were less accurately ranked, which confirms the hypothesis of a constant underlying structure allowing for more accurate perception of age in terms of changes by produced growth. The subjects reported that they used a conscious cognitive strategy of comparing what they already knew with what they saw in the faces, which strongly supports the ecological view of perception. Growth is a common and important aspect of the environment, as the authors conclude in the first reported article (1975 a, p. 382). Information related to growth can, therefore, be immediately picked up once the kind of change is known.

A concept cannot be and needs not be captured in its entire dimensionality in order to be understood. In the case of "Growth" two components are enough for simulation, which means that it is possible to observe the concept, i.e. there exists a structure. As long as the existence of structure has not been detected one may hardly talk about *the* concept either, a reason why it is not directly observable. It is unfreezed. Growth, on the other hand, as existing structure, was freezed and could be exemplified for direct observation in an experimental setting, which is one way of making the concept visible. Single events making up a concept lead to knowledge of the dimensionality of the phenomenon. But the profiles or heads could not tell the events of growth. Thus, the knowledge that structure exists does not mean knowledge of its dimensionality.

The difference between freezed and unfreezed concepts can easily be explained by the ecological model. The first has reached a phase where its boundaries are defined and aspects (such as "aging") easily symbolized. The latter has not yet reached that phase. As unfreezed it is in the coming. This explains on the one hand why an unfreezed concept is not immediately observable in the course of symbolic processing and on the other why its dimensionality could be made visible. As expressed by the notion "label", an unfreezed concept is without any structural component at the beginning. It only addresses complexity. However, labels may be assigned structural information and thus, be understood as expression of special value. Though, the conceptual information that they symbolize is dependent on the method used for generation, which means that concepts can only be operationally defined. From an ecological point of view, the method is contextually determined in the sense that it may vary between disciplines or scientific communities. As a result, the understanding of a concept may differ from one research environment to another. Further, if the method governs the way of conceiving the research problem, or conversely, if the problem formulation has a steering effect on choice of method, then it should not be surprising that the structural invariance inherent in a certain concept shows dimensional diversity and, hence, is inappropriate for communication outside the scientific context.

Conclusions

A long tradition in science and philosophy of language asserts that natural language is insufficient in allowing anyone to precisely and completely express his knowledge. The solution proposed by philosophers, mathematicians and computer scientists has been to develop formal or artificial languages. The dominant aspect of artificially designed languages for operations in a universe is, according to a study carried out by Miller (1981), an elaborate organization of controls manifested by DO- and IF-expressions. Within these primary data manipulation activities are enclosed. For this reason, Miller labels expressions in artificial language "conditionalized actions". The attempts to develop a computational semantics, i.e. procedural specifications in order to describe facts of the world within the framework of a universe, has led computer scientists (e.g., Collins & Quillian, 1969) to use the homogeneous and linear passing time as well as the invisible extending distance of the universe to compute the organized complexity of amounts of facts put into the universe. Consequently, time and distance have been used to compute relatedness of processes in the hardware by processing-time measurements.

Despite an uneasiness felt by scientists when confronted with the problem of making specific and precise statements in natural language, we have no doubt in the power of natural language. The importance of distinction and abstraction in the study of natural language has rapidly emerged, since it has become obvious over the past few years that cognition oriented researchers have generally been unsuccessful in inferring the nature of a person and its surrounding world from the identification of geometrical patterns of artificially encoded material. As a result, we have introduced the ecological approach to natural language study proposing that meaning (Bierschenk, 1984 a), understanding (Bierschenk, 1986), and knowing (Bierschenk & Bierschenk, 1986) can only be communicated through natural language. The distinction is made between the person's ability to perceive apparent motion and his ability to extract invariants out of a "sequence". An ecological study of language, then, is concerned with peoples' ability to use their language to approach and specify problems, particularly problems that lie beyond

the well-formed domain of formal logics.

By making explicit reference to the process of perceiving the structure of the world we refer neither to pictorial or image-like thought nor to thought that is verbal or symbolic. We assume with Gibson (1979) higher order relations as common basis for objects and events to become knowable, because these relations capture their crucial qualities of structure and form. The concept of structure is used to distinguish actual but abstract relations, in which objects and events are embedded, from generalized patterns. This use of the concept is essential to a psychological or any other empirical study of expression. Especially in the study of language, it is very easy to find the concept of structure confused with the concepts of form and organization. The same applies to computer science, where purely combinatorial or syntactic approaches blur a clear understanding of what issue is under study. A set of interrelated features may constitute a pattern, a domain, or a group, or composite, but it does not constitute a structure. Therefore, a set of primitives, logical terms, or graphical elements may be sufficient for generating complexity, but definitely insufficient for providing information. In accordance with this view, psychological processes that pick up information are considered distinctly different from mechanical processes implying a composition of a copy, which can be stored, accessed and retrieved from the computer or any other "memory". Thus, an ecological approach to a psychological study of language examines its degree of structure (variability) and degree of organized complexity (form of symbolism).

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